

DOCUMENT RESUME

ED 141 337

SP 011 218

AUTHOR Zauner, Christian W.; Benson, Norma Y.
TITLE Physiological Alterations Observed in Young Competitive Swimmers During Three Years of Intensive Training.
PUB DATE 77
NOTE 8p.
EDRS PRICE MF-\$0.83 HC-\$1.67 Plus Postage.
DESCRIPTORS *Athletes; *Children; Exercise (Physiology); *Growth Patterns; Heart Rate; Human Body; Muscular Strength; Performance; Physical Characteristics; *Physical Development; Physical Fitness; *Physiology; *Swimming

ABSTRACT

This investigation sought to determine whether the excellent performer evolves from typical material through training or if he brings facilitating characteristics with him to practice on the first day. Subjects were highly successful AAU age-group competitors who had invested at least 50 percent of their lives in swim training. These seven female and eight male child swimmers (active in a year-round training program) were measured for maximal oxygen consumption (VO2 max), physical work capacity when the heart rate is 170 beats/minute (PWC 170), forced vital capacity (FVC), and body surface area (ESA). Measurements were done in early fall 1973, 1974, and 1975 following termination of the previous summer's meet season. Data evolving from the measurement of each parameter were analyzed with a two-way analysis of variance. It was concluded that as an outcome of training, young athletes show progressive increase in VO2 max and PWC 170. Furthermore, the FVC may be increased beyond expectations through prolonged intensive training in childhood. This latter phenomenon might be a function of increasing numbers of alveolar sacs. Tables are included. (MM)

* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *

ED141337

PHYSIOLOGICAL ALTERATIONS OBSERVED IN YOUNG COMPETITIVE
SWIMMERS DURING THREE YEARS OF INTENSIVE TRAINING

Christian W. Zauner
Norma Y. Benson

In spite of copious research focused on the athlete, it remains impossible to discern whether the excellent performer evolves from typical material through training or if he brings facilitating characteristics with him to practice on day one. In an effort to provide clarifying data in this area, seven female and eight male child swimmers, active in a year-round training program were measured for $\dot{V}_{O_2\max}$, PWC₁₇₀, FVC and for BSA. Furthermore, a predicted FVC based on age, sex and body size was made for each subject. Measurements were done in early Fall 1973, 1974 and 1975 following termination of the previous summer's meet season.

The children were highly successful AAU age-group competitors jointly accounting for more than sixty Florida AAU and Junior Olympic titles acquired during the three year study period. Several had qualified for either junior or senior national AAU Championships, with second and fourth place finishes representing best performances at those levels. Each athlete, even the youngest (9 years) had at least fifty percent of his life invested in swim training, thus creating a prejudice against finding physiological superiorities attributable to subsequent training. The summer training regimen included two-a-day practices totaling 12,000-15,000 yards daily. However, most swimmers typically had just completed a taper prior to measurement. The winter training program brought athletes to the practice pool at least six times a week with long yardage and weight training as features.

The $\dot{V}_{O_2\max}$ was elicited through an intermittent treadmill run preceded by a five-minute continuous treadmill walk at 3.5 mph with elevations at the end of each minute until slope equalled 5%. Running was then initiated at 6.0 mph for subjects 10 years old and younger, 6.5 mph for those 11 to 13 years old, 7.0 mph for children between 14-18 and 7.5 mph for the lone 19 year-old. The initial slope was always 0% with elevations of 2.5% each succeeding minute. Subjects ran for one minute at each elevation and rested for from one to two minutes between runs. Expired air samples were collected in Saran plastic bags during the last 30 seconds of runs occurring after achievement of a pulse rate of 160 bpm. Intermittent running at constantly increasing slopes was continued until the subject declared fatigue or until a pulse rate of 200 bpm was observed. Collected air samples were examined for %O₂ and %CO₂ via paramagnetic and infrared analysis respectively. The $\dot{V}_{O_2\max}$ was calculated by the classic formulae and expressed as ml/kg·min. All subjects achieved maximum as indicated by no increase in $\dot{V}_{O_2}$ in the face of increasing workload. At least four expired air samples were acquired from each subject at each testing.

The FVC, BSA and PWC₁₇₀ were measured on a second day. A 13.5 liter Collins respirometer was employed to assess FVC, and PWC₁₇₀ was estimated with a Monark bicycle ergometer. The working capacity test was progressive with increments each six minutes. Total work done to pulse rate 170 was divided by body weight in kg to compensate for changes in size due to growth from year to year. Thus, PWC₁₇₀ was expressed as kgm of work done per kg of body weight.

Data evolving from measurement of each parameter were analyzed with two-way analysis of variance.

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

SP011 218

TABLE 1

Even though size compensated to account for changes due to growth, mean $\dot{V}_{O_2\max}$ increased significantly from year to year, and was consistently greater in the males.

TABLE 2

Size-compensated PWC_{170} significantly increased from year to year and, as with $\dot{V}_{O_2\max}$, was consistently greater in the males.

TABLE 3

Since there were more very young athletes (initial age 9-12 years) in the studied male population than among the female group, no significant differences in BSA between sexes were noted, although progressive significant increases were observed for both groups.

TABLE 4

The observed FVC followed a pattern similar to that for BSA, demonstrating significant increases with time but without differences between sexes.

TABLE 5

The 1973 mean observed FVC was 103.8% of predicted. In 1974 it was 108.5% of predicted and the observed 1975 mean FVC was 109.1% of the predicted value. The mean observed FVC became significantly greater than predicted after 1973.

In consideration of the duration of involvement in training by these subjects prior to initial measurement, the significant increases in $\dot{V}_{O_2\max}$, PWC_{170} and FVC from year to year are impressive. It deserves to be mentioned that the coach and program remained unchanged during the three years so that improvements are unlikely to be related to great variations in training intensity.

In 1974 Cunningham and others (1) reported an increase in absolute lung weight, lung volume per unit body weight, TLC and number of alveoli in rats maintained in an hypoxic condition from birth for 21 days. Later, Burri and others (2) created hyperactivity in young mice with IDPN administration. Saline treated controls were found to have a smaller mean lung volume per unit body weight than that of the active group. Recently, Fu (3) reported increased numbers of alveoli in rats exercise trained for the first three months of life. No such change was observed in later months. Human studies usually reveal no significant increases in static lung volumes attributable to training in adults.(4,5) We have earlier reported increases in DL_{CO} beyond predicted in training children (6). The DL_{CO} is partially dependent upon extent of the alveolar membrane. In view of these findings it seems reasonable to hypothesize that increases in FVC beyond predicted may be due to alveolar hyperplasia.

In summary, as an outcome of training, young athletes show progressive increases in $\dot{V}_{O_2\max}$ and PWC_{170} . Furthermore, the FVC may be increased beyond expectations through prolonged intensive training in childhood. This latter phenomenon might be a function of increasing numbers of alveolar sacs.

TABLE 1. $\dot{V}_{O_2}$ MAX, ML/KG • MIN

SUBJECT		1973	1974	1975
♀	1	44.82 (14)	55.18	56.24
	2	52.80 (15)	46.71	47.79
	3	40.61 (13)	45.89	45.00
	4	42.40 (14)	34.39	39.44
	5	28.47 (15)	41.67	44.31
	6	29.85 (13)	44.77	46.96
	7	42.77 (17)	39.46	56.27
$\bar{X}_{\text{♀}} =$		40.246 14.4	44.010	48.001
♂	8	45.37 (14)	66.78	59.86
	9	43.80 (12)	54.94	69.53
	10	48.90 (16)	52.73	68.24
	11	45.69 (9)	41.77	46.18
	12	53.40 (15)	58.24	68.24
	13	53.99 (19)	49.03	66.49
	14	39.17 (9)	60.79	65.33
	15	49.38 (10)	57.79	68.41
$\bar{X}_{\text{♂}} =$		47.463 13.0	55.259	64.035
$\bar{X}_T =$		44.095 13.7	50.009	56.553

TABLE 2. PWC_{170} , KGM/KG

SUBJECT		1973	1974	1975
♀	1	115.34 (14)	125.43	116.24
	2	62.36 (15)	75.63	89.94
	3	75.57 (13)	71.77	85.62
	4	76.15 (14)	82.22	68.59
	5	87.89 (15)	83.54	81.82
	6	101.28 (13)	86.94	126.98
	7	134.01 (17)	155.25	155.05
$\bar{X}_{\text{♀}} =$		93.229 14.4	97.254	103.463
♂	8	102.27 (14)	112.68	100.43
	9	112.50 (12)	182.85	180.98
	10	207.24 (16)	199.74	279.73
	11	68.78 (9)	84.97	97.00
	12	111.03 (15)	131.10	143.71
	13	216.33 (19)	153.65	223.20
	14	121.57 (9)	114.55	159.13
	15	95.42 (10)	109.99	160.28
$\bar{X}_{\text{♂}} =$		129.393 13.0	136.191	168.058
$\bar{X}_{\text{T}} =$		112.516 13.7	118.021	137.913

TABLE 3. FVC, LITERS

SUBJECT		1973		1974	1975
♀	1	3.29	(14)	3.68	4.04
	2	3.68	(15)	4.31	4.21
	3	2.76	(13)	3.34	3.49
	4	3.35	(14)	3.98	4.42
	5	3.78	(15)	3.45	4.11
	6	3.24	(13)	3.72	3.73
	7	4.21	(17)	4.64	4.70
$\bar{X}_{\text{♀}} =$		3.473	14.4	3.874	4.100
♂	8	4.75	(14)	5.46	5.52
	9	3.45	(12)	4.10	4.37
	10	5.45	(16)	5.85	5.61
	11	1.90	(9)	2.16	2.24
	12	3.40	(15)	4.27	4.42
	13	6.10	(19)	6.15	6.82
	14	2.28	(9)	2.48	2.58
	15	2.21	(10)	2.48	2.61
$\bar{X}_{\text{♂}} =$		3.693	13.0	4.119	4.271
$\bar{X}_{\text{T}} =$		3.590	13.7	4.005	4.191

TABLE 4. BSA, m²

SUBJECT		1973	1974	1975
♀	1	1.48 (14)	1.56	1.60
	2	1.70 (15)	1.75	1.76
	3	1.55 (13)	1.60	1.70
	4	1.72 (14)	1.72	1.80
	5	1.52 (15)	1.54	1.58
	6	1.32 (13)	1.51	1.57
	7	1.77 (17)	1.75	1.75
$\bar{X}_{\text{♀}} =$		1.580 14.4	1.633	1.680
♂	8	1.54 (14)	1.70	1.90
	9	1.40 (12)	1.45	1.62
	10	1.83 (16)	1.86	1.87
	11	1.00 (9)	1.03	1.12
	12	1.50 (15)	1.66	1.74
	13	2.11 (19)	2.12	2.08
	14	0.99 (9)	1.08	1.18
	15	1.03 (10)	1.07	1.15
$\bar{X}_{\text{♂}} =$		1.425 13.0	1.503	1.533
$\bar{X}_{\text{T}} =$		1.497 13.7	1.563	1.628

TABLE 5. MEAN FVC IN LITERS, PREDICTED VERSUS OBSERVED.

YEAR	PREDICTED	OBSERVED	<u>t</u> - RATIO
1973	3.460	3.590	1.327
1974	3.690	4.005	2.341 *
1975	3.840	4.191	2.372 *

* $P < .05$